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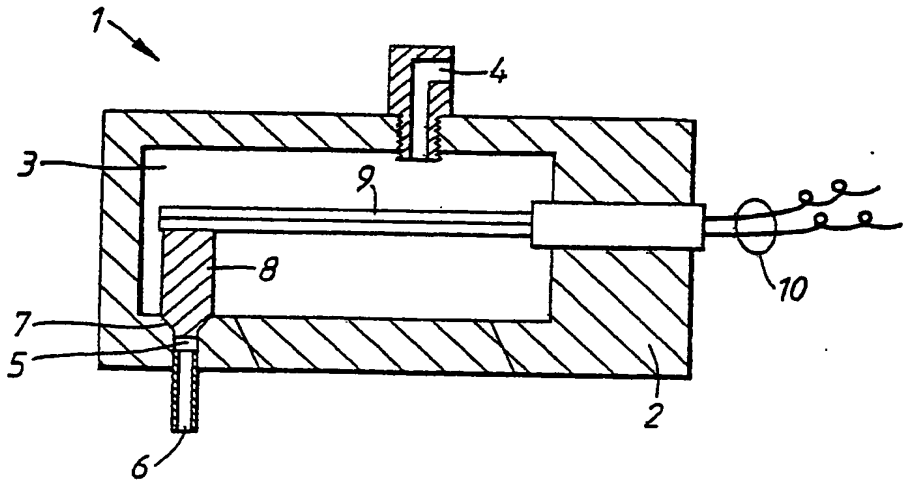

(57) Abstract

A fluid applicator, e.g. for adhesive, comprises a body (2) defining a reservoir (3) to which fluid is fed under pressure via an inlet (4). An outlet passage (5) is normally closed by a closure member (8). The closure member (8) may be reciprocated at high speed (e.g. $1KH_3$), and each reciprocation causes a small volume of fluid to be forced by the closure member into the outlet passage, and corresponding volume of fluid to be ejected from nozzle (6) as a small dot. Actuations of the device may be under program control.

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FLUID APPLICATOR

This invention relates to a fluid applicator, that is to say a device for applying a fluid to a body, e.g. of paper or cardboard. The preferred embodiment of the invention is particularly suitable for the application of liquid adhesive materials, although the invention is not limited to this use.

Conventional techniques for the application of adhesive materials during automated manufacture have included the use of spray nozzles and flow nozzles controlled by solenoid valves, and the use of mechanical transfer rollers or bars for transferring adhesive from a reservoir onto the surface to be coated. None of these techniques readily admits to precise control of the shape, position, and area of adhesive applied under all manufacturing conditions, and in particular none of the prior art techniques is suitable for applying a well defined elongate bar of adhesive to a rapidly moving web of material when the bar is orientated other than with its longitudinal axis parallel to the direction of movement of the web. This disability stems from the limited speed of operation of transfer mechanisms that operate intermittently, and the inability of prior art nozzle arrangements to be controlled accurately and rapidly.

According to one aspect of the present

invention there is provided a fluid applicator comprising a fluid reservoir; an outlet passage leading from the fluid reservoir to a nozzle; a closure member normally closing the outlet passage but reciprocable within the reservoir in a direction generally parallel to the axis of the passage to repeatedly open and close the passage, each passage closure resulting in a small volume of fluid from the reservoir being forced by the closure member into the passage to eject a corresponding volume of fluid from the nozzle.

The preferred embodiment of fluid applicator when used to apply adhesive material, has the advantage that it can be controlled with great precision enabling the flow of adhesive to be turned "on" and "off" in a precisely defined manner, thereby enabling adhesive areas to be set down with considerable precision. Further, the preferred fluid applicator is particularly suitable for electronic control thereby enabling the size, shape, and position of adhesive patterns to be controlled easily by use of a computer. This is of particular advantage since details of a particular adhesive pattern may be readily set up in the computer, and stored for future production runs requiring the same pattern.

The invention will be better understood from the following description of preferred embodiments thereof, given by way of example only, reference being had to the accompanying drawing wherein:

Figure 1 is a schematic cross-section of one embodiment of the invention; and

Figure 2 is a schematic cross-section of a second embodiment of the invention.

The fluid applicator shown in Figure 1 comprises a body 2 defining a fluid reservoir 3 to which fluid is supplied via an inlet 4. The fluid will typically be an adhesive, and is supplied to the inlet

4 under pressure to maintain a predetermined pressure within the reservoir 3.

An outlet passage 5 leads from the reservoir 3 to a nozzle 6. The end of the passage 5 nearest the reservoir 3 is conical and forms a seat 7 for a closure member 8 which is normally biased into engagement with the seat 7 to close the outlet passage to fluid flow. The closure member 8 is mounted on an actuating mechanism 9 which can be controlled by electrical signals supplied to wires 10 connected to the actuating mechanism 9. By supplying appropriate control signals via the wires 10 the actuating mechanism 9 can operate to move the closure member 8 upwardly as illustrated in the drawing, i.e. in the axial direction of the passage 5. When the closure member is so moved fluid within the reservoir 3 fills the conical upper end of the passage. When the closure member is subsequently rapidly returned to the position illustrated in the drawing a small volume of fluid is forced along the passage 5 causing a corresponding volume of fluid to be ejected from the nozzle 6.

In use the closure member 8 is reciprocated rapidly to eject a series of dots or droplets of fluid from the nozzle 6. In one preferred embodiment of the invention the closure member 8 is reciprocated at a frequency of 1000 Hz to produce a corresponding stream of dots of fluid at a rate of 1000 dots per second. The size of the dots may be adjusted by adjusting the size of orifice 6 and/or the pressure of fluid within the reservoir 3, and the frequency at which dots are emitted may be adjusted by varying the frequency of reciprocation of the closure member 8. By a suitable combination of these variables the rate of fluid ejected in terms of volume per unit time may be varied over a wide range in accordance with

the nature of the fluid to be applied and the nature and speed of movement of the web to which the fluid is applied.

A typical use of the applicator 1 is to apply adhesive to a moving web of material, for example a moving web of paper in a business forms production machine, packaging machinery, or paper conversion machinery. In this case, if the moving web travels at constant speed and in a constant direction below a fixed applicator the applicator will, when ejecting fluid, produce on the moving web a line of dots. The diameter of the dots will be determined by the physical parameters of the applicator and the fluid being ejected, and the position of the dots relative to each other will be determined by a combination of the frequency of reciprocation of the closure member 8 and the speed of movement of the web. For a given web speed the frequency of reciprocation will be selected to give the desired dot spacing. It may be desirable for the individual dots to overlap so that whilst the applicator is actuated a continuous line of adhesive is produced, or it may be desirable to have discrete dots, depending on the circumstances.

Because the above described applicator only produces a series of ejected dots when the actuating mechanism 9 is operational the applicator can readily be turned on and off under electrical or electronic control. During "on" periods the closure member 8 is reciprocated as described above to produce a series of dots, and during "off" periods the closure member rests in the position illustrated in the drawing to prevent the escape of fluid from the reservoir 3. This control facility enables the length of adhesive line (measured in the direction of web movement) and the position of the adhesive line (in the direction of web movement) to be accurately controlled. Typically, an adhesive line having a length of 6 mm can be laid down with precision. By arranging a plurality of applicators as described

above in side-by-side relationship such that the lines of adhesive produced by each nozzle 6 overlap, and controlling each of the actuating mechanisms 9 to produce a desired pattern of adhesive it will be appreciated that the size, shape, and position of an adhesive pattern laid down on a moving web of material may readily be controlled. For example, if a bank of applicators 1 is located across the full width of a web of moving material and the actuating mechanisms 9 are controlled to switch all the applicators on and off simultaneiously for a short period a line of adhesive running transverse to the direction of movement of the web can be laid down with precision. Typically, a line of adhesive 6 mm wide can readily be laid down in this manner.

It will be further appreciated that the individual actuating mechanisms 9 can be controlled separately to produce any desired adhesive pattern on the moving web. For example, chevron shaped bars of adhesive or wavey lines of adhesive can be produced in any orientation relative to the direction of movement of the web by suitable control of the actuating mechanisms. Such control is preferably effected electronically under program control. For example, a computer may be used to set up a particular pattern of adhesive on a screen and the pattern so set up may automatically be reproduced by the applicators under program control.

One typical use of the present invention is in the formation of continuous business forms which may consist of several webs of paper secured together by lines of adhesive along the laterial edges of the webs. Applicators as described above may be used to apply continuous lines of adhesive along the laterial edges of the webs, or broken lines or even a series of individual dots. Further, suitable banks of applicators

arranged across the direction of the web may be used to lay down lines of adhesive transverse to the web direction for example to connect together the top edge of a set of business forms, or to form sealed envelopes consisting of two or more webs of material united together along four sides. In addition to the business forms production industry applicators described above are potentially of value in the packaging industry, e.g. in the formation of cartons, and in the paper conversion industry.

Preferably, each body 2 houses a number of passages 5 and corresponding closure members 8 to produce an applicator unit which can lay down a number of overlapping lines of adhesive. A single such unit may be used to span the full width of a web of material or several such units may be assembled together to form a complete fluid applying machine.

The actuating mechanism 9 may be of any suitable type able to reciprocate the closure member in the manner required. In the embodiment shown in Figure 1 a piezo-ceramic actuator is used.

The embodiment shown in Figure 2 is similar to that of Figure 1 in that it comprises a body 2 defining a reservoir 3 to which fluid is supplied via an inlet 4 and from which fluid is ejected into an outlet passage 5 by reciprocation of a closure member 8A. In the case of the Figure 2 arrangement the closure member 8A is mounted on a tensioned wire 11 which passes through insulating bushes 12,13 and to the free ends 14,15 of which are connected the control wires 10 of the associated control equipment. The closure member 8A is mounted in a magnetic field the lines of force of which run perpendicular to the plane of the paper so that when a suitable A.C. current is fed through the wire 11 the closure member is reciprocated by a magneto-galvanic effect.

Any other suitable system for reciprocating the

closure member may be adopted, for example a high speed solenoid system. The exact nature of the mechanism for reciprocating the closure member is not critical and any arrangement which can reciprocate the closure member at the desired frequency and which is susceptible to electrical or electronic control may be used. It should also be noted that the shape of the passage and the closure member may be different from that illustrated. It has been found that various combinations of passage shape and closure member shape give satisfactory results, and any combination of shapes which results in the ejection of a droplet of fluid from the nozzle each time the closure member is reciprocated may be used. It should be understood that the invention operates by positively ejecting a stream of droplets from the nozzle rather than simply opening and closing a valve at the outlet of a pressurized vessel of fluid, and any combination of passage and closure member which provides the required positive ejection of droplets of fluid is within the scope of the invention.

Whilst in general the frequency of reciprocation of the closure member and the speed of movement of the web will be such that the dots of fluid, when they hit the web, will spread out to overlap each other so that when the applicator is "on" a continuous line of fluid is laid down on the web, it should be understood that for some applications the speed of movement of the web may be such that the dots do not overlap, and accordingly a line of dots is laid down when the applicator is "on". Also, the applicator may be such that the closure member can be held in the open position, thereby enabling a continuous stream of fluid to flow from the applicator.

Preferably, a plurality of applicators are associated with a microcomputer control unit which automatically turns each applicator on and off under program

control to lay down the desired pattern of fluid on a moving web. The applicators may be arranged in a single row across the web, or in a plurality of mutually offset rows. If offset rows are used, the control unit preferably automatically compensates for the offset when turning the applicators on and off. The control unit may incorporate a screen to enable an application pattern to be set up and dimensionally verified for size and position using only the control unit. Additionally or alternatively the control unit may accept programming from another computer either by direct connection (temporary or permanent) or by use of some machine readable transfer medium e.g. a magnetic disc or tape.

Finally, whilst the invention has been described with particular reference to the application of liquid adhesive to a moving web, it will be appreciated that the applicators, and the associated control systems, have a wide range of other applications. For example, the fluid applied may be a liquid or a flowable powder, and may be other than an adhesive. A specific example of an alternative use of the applicator is the application of liquid ink in a desired pattern, e.g. to print information such as packaging data on cardboard cartons.

CLAIMS

1. A fluid applicator comprising a fluid reservoir; an outlet passage leading from the fluid reservoir to a nozzle; a closure member normally closing the outlet passage but reciprocable within the reservoir in a direction generally parallel to the axis of the passage to repeatedly open and close the passage, each passage closure resulting in a small volume of fluid from the reservoir being forced by the closure member into the passage to eject a corresponding volume of fluid from the nozzle.

2. A fluid applicator according to claim 1 wherein the end of the outlet passage adjacent the reservoir is conical and forms a seat for the closure member.

3. A fluid applicator according to claim 2 wherein a portion of the closure member is conical and mates with the conical seat.

4. A fluid applicator according to claim 2 or claim 3 wherein the outlet passage down stream of the conical portion is substantially cylindrical, and the closure member includes a cylindrical extension which is located in the cylindrical portion of the outlet passage when the closure member is in its normal position closing the outlet passage.

5. A fluid applicator according to any preceding claim wherein the reservoir is formed by a body which has a plurality of said outlet passages extending from the reservoir, each passage being provided with a respective closure member whereby the applicator can lay down a plurality of rows of dots.

6. A fluid applicator according to claim 5 wherein the rows of dots overlap each other.

7. A fluid applicator according to claim 5 or claim 6 wherein the closure members may be separately controlled.

8. A fluid applicator according to any preceding claim wherein the reciprocation of the or each closure member is under the control of a computer program.

9. A fluid applicator according to any preceding claim wherein the fluid applied is liquid adhesive.

10. A fluid application system comprising at least one applicator according to any preceding claim, and a computer control unit for controlling operation of the or each applicator, the control unit incorporating a screen on which the desired pattern of application can be set-up using the control unit.

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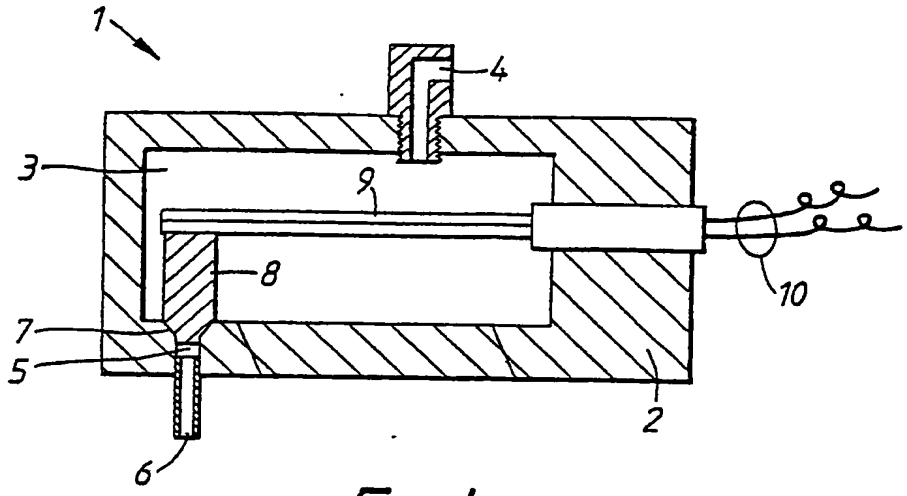

FIG. 1.

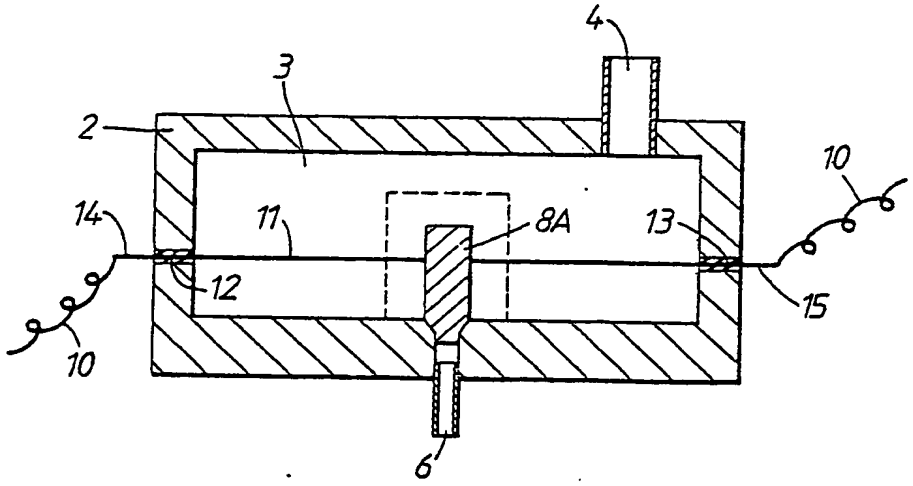

FIG. 2.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 86/00173

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: B 05 B 17/04; B 41 J 3/04

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	B 05 B B 41 J

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	US, A, 2951894 (HIRSCH) 6 September 1960, see column 4, lines 48-59; figures 1,2	1-3
X	FR, A, 2096753 (GRAFFMAN) 2 February 1972, see page 4, line 27 - page 5, line 11; figures 1,2	1
A	FR, A, 2357803 (DOMINION TOOL) 3 February 1978, see page 10, lines 33-36; figure 3	4
A	US, A, 4488665 (COCKS et al.) 18 December 1984, see column 6, lines 23-29; figures 2-4	5,7-10
A	US, A, 4247047 (SCHAMING) 27 January 1981, see column 3, lines 61-64; figure 2	6

* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
26th June 1986	30 JUL 1986
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	M. VAN MOL

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/GB 86/00173 (SA 12757)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 14/07/86

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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A- 2951894		None		
FR-A- 2096753	25/02/72	DE-A-	2125009	02/12/71
		GB-A-	1345896	06/02/74
FR-A- 2357803	03/02/78	DE-A-	2730375	12/01/78
		JP-A-	53007870	24/01/78
US-A- 4488665	18/12/84	None		
US-A- 4247047	27/01/81	None		

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